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Remarks

I.   Status of claims

Claims 1-31 were pending.

Claim 12 has been allowed.

The Examiner has indicated that claims 23-26 would be allowable if rewritten in independent form.

The elements of claim 22 and allowable claim 25 have been incorporated into claim 20, which has been rewritten in independent form. Since claim 20 now incorporates the elements of claim 25, claim 20 now should be in condition for allowance. Claims 21, 23, 24, 26, and 27 depend from independent claim 20 and therefore should be in condition for allowance for at least the same reasons.

Claims 22, 25, and 29 have been canceled without prejudice.

II.   Notice of references cited

The Examiner appears to have forgotten to include with the final Office action a copy of a Notice of References Cited form that lists the reference Deshpande et al. (U.S. 2003/0081854), which was cited against claim 22 in the final Office action dated August 9, 2007 (see page 20 § 15).

Applicant asks the Examiner to include with the next correspondence a copy of the Notice of References Cited form that lists the reference Deshpande et al. (U.S. 2003/0081854).

III.   Claim objections

The Examiner has objected to claims 18-20 and 31.

Regarding claims 18-20, the Examiner has stated that "Claims 18-20, line 2 respectively: 'inverse transform' should be --the intermediate images --as described on page 13, lines 8-11 of the specification." The specification, however, explains that "The terms inverse transforms (C^{-1}_1, C^{-1}_2, ..., C^{-1}_K) and intermediate images (I_1, I_2, ..., I_K) are used synonymously herein" (page 13,

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lines 2-4). Moreover, the term "inverse transform" is the term used in claim 1, from which claims 18-20 depend. For these reasons, the objection to claims 18-20 should be withdrawn.

Claim 31 has been amended in ways that address the concerns noted by the Examiner. The objection to claim 31 now should be withdrawn.

IV.   Claim rejections under 35 U.S.C. § 101

The Examiner has rejected claim 30 under 35 U.S.C. § 101.

Claim 30 has been amended in ways that address the Examiner's concerns in this regard. The rejection of claim 30 under 35 U.S.C. § 101 now should be withdrawn.

V.   Claim rejections under 35 U.S.C. § 112

The Examiner has rejected claims 8, 13, and 27 under 35 U.S.C. § 112, second paragraph, "as being indefinite."

A.   Claim 8

Regarding claim 8, the Examiner has stated that:

> Re Claim 8: Due to the amended limitation of "nonlinear" mapping to claim 1, this claim is rendered indefinite because it is unclear how F specifies a non-linear mapping from coefficients of D to coefficients of Z (as recited in claim 1) and also F specifies a linear mapping of coefficients of D to coefficients of Z having values 0 and ± 2N (linear mapping) in the same claim. Having F specifying a non-linear mapping in claim 1 and then having F specifying a linear mapping in dependent claim 8 is contradictory.

The Examiner apparently has misread claim 8. In particular, claim 8 recites that "F is a mapping from coefficients of D to corresponding coefficients of Z having values selected from 0 and ±2N where N has an integer value." Claim 8 does not define how the coefficients of Z are "selected from 0 and ±2N where N has an integer value." Consequently, there is no basis for the Examiner's assumption that claim 8 requires F to be a linear mapping.

For at least this reason, the rejection of claim 8 under 35 U.S.C. § 112, second paragraph, should be withdrawn.

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B.   Claim 13

Regarding claim 13, the Examiner has stated that:

> Re Claim 13: This claim is rendered indefinite and unclear because
> there is no antecedent basis for the limitation "weighted by
> respective scaling factors". It seems this claim should be dependent
> upon claim 10 instead of claim 9 and if this is the case, original
> claim 12 and amended claim 13 would be respectively the same.
> This claim is suggested to be deleted.

The Examiner apparently has misread claim 13. Claim 13 recites that "the denoising comprises applying to the forward transforms nonlinear mappings derived from the quantization values linked to the input image and weighted by respective scaling factors." Claim 13 does not make reference to any earlier recitation of "weighted by respective scaling factors." Therefore, there is no lack of antecedent basis with respect to this claim language.

For at least this reason, the rejection under 35 U.S.C. § 112, second paragraph, should be withdrawn.

Claim 13 has not been rejected on the basis of prior art or any other reason. Therefore, claim 13 now should be allowable.

C.   Claim 27

Regarding claim 27, the Examiner has stated that

> Re Claim 27: Due to the amended limitation of "The method of
> claim 22" to claim 27, this claim is rendered indefinite and unclear
> because there is no antecedent basis for the limitations "the base
> image contribution" and "the ringing correction image
> contribution". It seems this claim should be dependent upon claim
> 26 instead of 22. Therefore, "The method of claim 22" is suggested
> to be --The method of claim 26 --.

Claim 27 has been amended in ways that render the Examiner's concerns in this regard moot. The rejection under 35 U.S.C. § 112, second paragraph, now should be withdrawn.

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VI. Claim rejections under 35 U.S.C. § 103

A. Claims 1-11, 15, 16, 18-21, and 28-31

The Examiner has rejected claims 1-11, 15, 16, 18-21, and 28-31 under 35 U.S.C. §

103(a) over Nosratinia ("Enhancement of JPEG-Compressed Images by Re-application of

JPEG") in view of Hallapuro (U.S. 7,082,450), Winger (U.S. 2004/0240556), and Malvar ("Low

Complexity Transform and Quantization in H.264/AVC").

1. Claim 1

Claim 1 has been amended and now recites:

> 1. A method of processing an input image compressed in accordance with a block discrete cosine transform (DCT) image compression process, comprising:
>
> computing spatially-shifted forward transforms of the input image, each of the forward transforms being computed based on a denoiser transform Z having an associated transpose Z', wherein a matrix multiplication between Z and Z' produces a diagonal matrix Λ, Z=F(D), F specifies a nonlinear mapping from coefficients of D to coefficients of Z, and D substantially corresponds to a frequency-domain transform;
>
> denoising the forward transforms based on nonlinear mappings derived from quantization values linked to the input image;
>
> computing spatially-shifted inverse transforms of the denoised forward transforms, each of the inverse transforms being computed based on Z and Z'; and
>
> computing an output image based on a combination of ones of the spatially-shifted inverse transforms.

Regarding Nosratinia, the Examiner has stated that (original emphasis):

> ... Nosratinia does not disclose or fairly suggest exactly how each of the forward transforms are being computed based on a denoiser transform Z, how to denoise the forward transforms based on

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nonlinear mapping, and that F specifies a <u>nonlinear</u> mapping from coefficients of D to coefficients of Z.

Indeed, Nosratinia does not teach or suggest "computing spatially-shifted forward transforms of the input image, each of the forward transforms being computed based on a denoiser transform Z having an associated transpose Z', wherein a matrix multiplication between Z and Z' produces a diagonal matrix Λ, Z=F(D), F specifies a nonlinear mapping from coefficients of D to coefficients of Z, and D substantially corresponds to a frequency-domain transform," as recited in claim 1. Instead, Nosratinia discloses a "postprocessing technique for the reduction of compression artifacts in JPEG-encoded images" that "uses the JPEG process itself to reduce the compression artifacts of the JPEG-encoded images" (page 1, last ¶ of § 1). That is, Nosratinia discloses an image enhancement process that enhances a compressed image (i.e., a JPEG image) using the same process (i.e., the JPEG process) that was used to compress the image.

Regarding Hallapuro, the Examiner has stated that:

> Hallapuro discloses how each of the forward transforms / desired transform matrix (col. 8, lines 51-53) are being computed based on a denoiser transform Z / A (col. 8, lines 51-53). The applicant describes the forward transform B is zxz.' and Hallapuro describes the desired transform matrix Y is AXA'. Note that the inverse transform would obviously be computed by inversing the above procedure, which is equivalent to what has been described by the applicant.

> Therefore, in view of Hallapuro, it would have been obvious to one of ordinary skill in the art at the time the invention was made to modify Nosratinia's method by including the computation of deriving the forward transforms by a denoiser transform Z in order to require less operations when the transform is applied to digital data (see Hallapuro, abstract, lines 3-6).

Hallapuro discloses approximations of the discrete cosine transform (DCT) for use in image compression (see, e.g., col. 1, lines 5-12). In accordance with Hallapuro's teachings, an image is compressed using a non-DCT transform and an associated quantization (see col. 5, lines 17-33) and the resulting compressed image is decompressed using a non-IDCT inverse transform and an associated dequantization that are designed specifically for decompressing such a compressed image (see col. 5, lines 34-47).

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The Examiner does not contend that Hallapuro discloses or suggests using his non-DCT transforms for image enhancement, much less for enhancing JPEG-encoded images. Instead, the Examiner simply argues that one skilled in the art at the time the invention was made would have been motivated to make such a substitution "in order to require less operations when the transform is applied to digital data." When applied to JPEG-compressed image, however, such a substitution would be contrary to Nosratinia's teachings. In particular, Nosratinia discloses an image enhancement process that enhances a compressed image (i.e., a JPEG image) using the same process (i.e., the JPEG process) that was used to compress the image. The substitution proposed by the Examiner would result in the processing of a JPEG-encoded image using a non-JPEG compression process (i.e., a compression process that is _different_ from the process that was used to compress the image).

Since the modification of Nosratinia's image enhancement process is contrary to Nosratinia's teachings and Hallapuro is silent on the issue, one skilled in the art would not have had any apparent reason to modify Nosratinia's method in the manner proposed by the Examiner.

The Examiner has attempted to cast his proposed modification of Nosratinia's method as a straightforward substitution of an element of Hallapuro for a comparable element of Nosratinia's method. Such a substitution, however, improperly goes only half-way towards the substitution of comparable elements. As a result, the substitution proposed by the Examiner would cause Nosratinia's method to process a JPEG-encoded image using a non-JPEG compression process (i.e., a compression process that is _different_ from the process that was used to compress the image), a modification which is contrary to Nosratinia's teaching. In order to constitute a substitution of comparable elements, both the input image and Nosratinia's method would have to be modified. In particular, the input image would have to be compressed using Hallapuro's non-DCT transform and associated quantization, and the resulting compressed image would have to be enhanced using the same non-DCT transform and associated quantization and the complementary non-IDCT inverse transform and associated dequantization. Such a substitution, however, would not result in the invention defined in claim 1.

Regarding Winger, the Examiner has stated that:

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Winger discloses how to denoise the forward transforms based on nonlinear mapping / threshold (Fig. 5, page 3, cols. [0034]-[0034]).

Winger discloses a "method for improving rate distortion performance of a compression system through parallel coefficient cancellation in a transform ..." (see abstract). In paragraph 34, Winger discloses setting "block coefficient values and the corresponding block-based measurement value SAVi to zero for blocks where the value of SAVi is less than a predetermined threshold..." where "the predetermined threshold used in setting the block coefficient values to zero may be based on a class of the block and/or a type of the macroblock containing the block..." (see ¶ 34). This disclosure would not have led one skilled in the art to modify Nosratinia's method in the manner proposed by the Examiner. Indeed, Winger does not disclose or suggest anything whatsoever about enhancing images, much less anything about using the JPEG process itself to reduce the compression artifacts of JPEG-encoded images.

The Examiner's conclusion that it would have been obvious to modify the teachings of Nosratinia based on the teachings of Winger is based on the following rationale (emphasis added):

> Therefore, in view of Winger, it would have been obvious to one of ordinary skill in the art at the time the invention was made to further modify Nosratinia's method as modified by Hallapuro, by including a thresholding block to denoise the forward transform <u>in order to reduce the white noise present and improve the rate-distortion</u> (see Winger, abstract, lines 1-2).

Contrary to the Examiner's assertion, however, neither the abstract, nor any other part of Winger's disclosure, discloses or suggests anything whatsoever about reducing white noise.

In lines 1-2 of the abstract, Winger merely indicates that his method improves rate distortion performance of an image compression system. Rate distortion, however, relates to determining the minimal amount of entropy that should be communicated over a channel, so that an input signal can be approximately reconstructed in an output signal within a given distortion level. Rate distortion is not implicated in Nosratinia's image enhancement process, which enhances a compressed image (i.e., a JPEG image) using the same process (i.e., the JPEG process) that was used to compress the image.

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In summary, the first rationale (i.e., "to reduce the white noise present") proffered by the Examiner in support of the incorporation of Winger's teachings into the combination of Nosratinia and Hallapuro is not supported by any of the cited references and the second rationale (i.e., improve rate-distortion) does not apply to Nosratinia's image enhancement process. For these reasons, the Examiner has not provided any apparent valid reason for one skilled in the art to modify Nosratinia's image enhancement method based on the teachings of Winger.

Without any apparent valid reason for modifying Nosratinia's teachings based on the teachings of Winger, the Examiner's rationale in support of the rejection of claim 1 amounts to no more amounts to no more than a conclusory statement which cannot support a rejection under 35 U.S.C. § 103. See KSR Int'l Co. v. Teleflex Inc., No. 04-1350, slip op. at 14 (U.S. Apr. 30, 2007) (citing In re Kahn, 441 F. 3d 977, 988 (CA Fed. 2006): "[R]ejections on obviousness grounds cannot be sustained by mere conclusory statements; instead, there must be some articulated reasoning with some rational underpinning to support the legal conclusion of obviousness").

Regarding Malvar, the Examiner has stated that:

> Malvar discloses F / round specifies a nonlinear mapping / round from coefficients of D / DCT to coefficients of Z / H (see Malvar, page 599, equation 3).

> Therefore, it would have been obvious to one of ordinary skill in the art at the time the invention was made to further modify Nosratinia's method and system, as modified by Hallapuro and Winger, using Malvar's teachings by including the nonlinear mapping to Nosratinia's mapping in order to improve compression efficiency and improve the PSNR while minimizing the computational complexity (see Malvar, page 599, left col., "For improved compression ... ", page 602, left col., "In some applications ... ", abstract).

Malvar merely presents an overview of the transform and quantization designs in the H.264 video coding standard. Like the transforms disclosed in Hallapuro, the transforms used in the H.264 standard are non-DCT transforms, each of which is associated with a respective quantization and a complementary non-IDCT inverse transform and associated dequantization. Thus, as explained above in connection with Hallapuro, the substitution proposed by the

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Examiner would result in the processing of a JPEG-encoded image using a non-JPEG compression process (i.e., a compression process that is _different_ from the process that was used to compress the image). Since the modification of Nosratinia's image enhancement process is contrary to Nosratinia's teachings and Malvar is silent on the issue, one skilled in the art would not have been led to modify Nosratinia's method based on Malvar's teachings in the manner proposed by the Examiner. The Examiner's proposed modification of Nosratinia based on Malvar improperly goes only half-way towards the substitution of comparable elements. As a result, the substitution proposed by the Examiner would cause Nosratinia's method to process a JPEG-encoded image using a non-JPEG compression process (i.e., a compression process that is _different_ from the process that was used to compress the image), a modification which is contrary to Nosratinia's teaching. In order to constitute a substitution of comparable elements, both the input image and Nosratinia's method would have to be modified. In particular, the input image would have to be compressed using Malvar's non-DCT transform and associated quantization, and the resulting compressed image would have to be enhanced using the same non-DCT transform and associated quantization and the complementary non-IDCT inverse transform and dequantization. Such a substitution, however, would not result in the invention defined in claim 1.

For at least the reasons explained above, the Examiner's rejection of claim 1 under 35 U.S.C. § 103(a) over Nosratinia, Hallapuro, Winger, and Malvar now should be withdrawn.

2. Claims 2-11, 15, 16, 18-21, and 31

Each of claims 2-11, 15, 16, 18, 19, and 31 incorporates the features of independent claim 1 and therefore is patentable over Nosratinia, Hallapuro, Winger, and Malvar for at least the same reasons explained above.

As explained above, claim 20 has been amended to incorporate the elements of allowable claim 25. Therefore, claim 20 is patentable over the cited references for at least the same reasons as claim 25. Claim 21 depends from claim 20 and therefore is patentable over the cited references for at least the same reasons.

Claims 8 is patentable over the cited references for the following additional reason.

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Claim 8 recites that "F is a mapping from coefficients of D to corresponding coefficients of Z having values selected from 0 and ±2N where N has an integer value."

The Examiner has explained his basis for rejecting claim 8 as follows:

> Re Claim 8: Nosratinia discloses a quantizer Q which to one of ordinary skill in the art at the time the invention was made could be considered as F, where F is a mapping from coefficients of D to corresponding coefficients of Z having values selected from 0 and ± 2N where N has an integer value because this type of quantizer is a typical quantizer used in many fields of endeavor.

Contrary to the Examiner's statement, however, Nosratinia's quantizer Q does not specify a nonlinear mapping from coefficients of D to coefficients of Z, where each of the forward transforms is computed based on Z, as recited in claim 1. In accordance with Nosratinia teachings, the forward transforms are computed before they are quantized by the quantizer blocks Q. Therefore, there is no basis for the Examiner's conclusion that one skilled in the art would have considered the quantizer Q to be F. Moreover, the quantizer Q does not specify a mapping from coefficients of the DCT transform to corresponding coefficients of a denoiser transform Z, which is used to compute spatially-shifted forward transforms of the input image as recited in claim 1.

In addition, the Examiner has not cited any support for his assertion that "this type of quantizer is a typical quantizer used in many fields of endeavor," nor has the Examiner explained where the motivation to modify Nosratinia's denoising process is found in any of the cited references or in the knowledge generally available at the time the invention was made. The Examiner again is requested to cite prior art that supports his assertions regarding the knowledge that was generally available and that establishes the requisite motivation for modifying Nosratinia's teachings in the manner proposed by the Examiner. Alternatively, if the Examiner is aware of facts within his personal knowledge that provide the requisite factual basis and establish the requisite motivation to support his deemed conclusion that the features recited in claim 8 would have been obvious, the Examiner is requested to provide an affidavit in accordance with 37 CFR § 1.104(d)(2). Otherwise, the Examiner's rejection of claim 8 should be withdrawn for this additional reason.

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In response to these points, the Examiner has stated that (see page 6 of the final Office action):

> The Applicant alleges, "Claim 8 recites that ..." in pages 16-17, and states respectively that Nosratinia doesn't teach the amended "nonlinear" mapping for claim 1 and requests that the Examiner cite prior art for the assertions regarding the motivation for the obvious statement introduced. However, the Examiner feels there is no need to fulfill the request to cite a prior art reference in light of the amended claim 1, because claim 8 now consists of a 35 U.S.C. 112, second paragraph issue as will be discussed in the 35 U.S.C. 112 rejections section of this Office Action

Since the "35 U.S.C. 112, second paragraph issue" has been shown to be a non-issue (see explanation given above), Applicant asks the Examiner to provide a proper response to the points raised above in connection with claim 8 or allow the claim.

3.   Claims 28-30

Each of independent claims 28-30 recites features that essentially track the pertinent features of independent claim 1 discussed above. Therefore, claims 28-30 are patentable over Nosratinia, Hallapuro, Winger, and Malvar for at least the same reasons explained above in connection with claim 1.

B.   Claim 14

The Examiner has rejected claim 14 under 35 U.S.C. § 103(a) over Nosratinia in view of Hallapuro, Winger, Malvar, and Merhav (U.S. 6,472,534).

Claim 14 incorporates the features of independent claim 1. Merhav does not make-up for the failure of Nosratinia, Hallapuro, Winger, and Malvar to teach or suggest the inventive method defined in independent clam 1. Indeed, like Hallapuro and Malvar, Merhav discloses a non-DCT transform and an associated quantization and a complementary non-IDCT inverse transform and associated dequantization. Therefore, claim 14 is patentable over Nosratinia, Hallapuro, Winger, Malvar, and Merhav for at least the same reasons explained above.

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C.   Claim 17

The Examiner has rejected claim 14 under 35 U.S.C. § 103(a) over Nosratinia in view of Hallapuro, Winger, Malvar, and Yonekawa (U.S. 5,046,121).

Claim 17 incorporates the features of independent claim 1. Yonekawa does not make-up for the failure of Nosratinia, Hallapuro, Winger, and Malvar to teach or suggest the inventive method defined in independent clam 1. Indeed, Yonekawa does not disclose or suggest anything whatsoever about enhancing images, much less anything about using the JPEG process itself to reduce the compression artifacts of JPEG-encoded images. Therefore, claim 17 is patentable over Nosratinia, Hallapuro, Winger, Malvar, and Yonekawa for at least the same reasons explained above.

Claim 17 also is patentable over the cited references for the following additional reasons.

Claim 17 recites "further comprising sharpening the forward transform coefficients by increasing nonlinear transform parameters by respective factors that are larger for higher spatial frequency forward transform coefficients than for lower spatial frequency forward transform coefficients."

The Examiner has taken the position that Yonekawa discloses the elements of claim 17 in col. 9, lines 23-25 and 38-40, and col. 3, line 67 - col. 4, line 4 (see page 20 of the final Office action). The Examiner's position, however, is not supported by Yonekawa's disclosure.

In col. 9, lines 23-25 and 38-40, Yonekawa describes the boundary for determining the number of transform coefficients to be cut. This disclosure has nothing whatsoever to do with "increasing nonlinear transform parameters by respective factors that are larger for higher spatial frequency forward transform coefficients than for lower spatial frequency forward transform coefficients."

In col. 3, line 67 - col. 4, line 4, Yonekawa discloses:

> The transform coefficients up to the cutoff frequency are quantized
> and coded, and the AC components higher than the frequency C
> are not handled as the substantial transform coefficients. Therefore,
> the AC components exceeding the cutoff frequency C are not
> coded or are coded as zero.

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This disclosure has nothing whatsoever to do with "increasing nonlinear transform parameters by respective factors that are larger for higher spatial frequency forward transform coefficients than for lower spatial frequency forward transform coefficients."

Therefore, contrary to the Examiner's statement, Yonekawa does not disclose the elements of claim 17. Claim 17 therefore should be allowed for this additional reason.

D.   Claim 22

The Examiner has rejected claim 14 under 35 U.S.C. § 103(a) over Nosratinia in view of Hallapuro, Winger, Malvar, and Deshpande (U.S. 2003/0081854).

The elements of claim 22 have been incorporated into claim 20, which has been amended to additionally incorporate the elements of allowable claim 25.

VII.   Conclusion

For the reasons explained above, all of the pending claims are now in condition for allowance and should be allowed.

Charge any excess fees or apply any credits to Deposit Account No. 08-2025.

Respectfully submitted,

Date: October 31, 2007
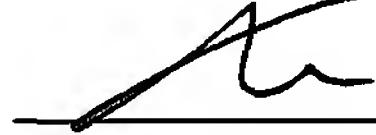
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